Water Contamination Risk Associated with Hydraulic Fracturing in the Marcellus Shale in Susquehanna County, Pa

BACKGROUND

Hydraulic fracturing, or fracking, is a process used to increase production of oil & gas in low permeability geologic formations. After a well has been drilled “fracking fluid” is pumped into the subsurface under high pressures to fracture the formation. A slurry mixture containing sediment, called proppant, is then pumped in to prop the fractures open. This material is more permeable than the bedrock and thus allows for easier flow of the target fuel to the well. (EPA, 2010 and Halliburton, 2008)

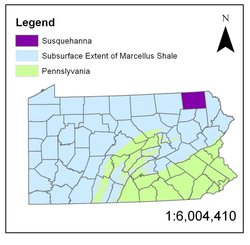
As the proppant is pumped in, some of the fracking fluid returns to the surface. The fluid is typically stored at the surface before it can be disposed of. Fluid may be stored in tanks or in open pits at the surface. It is then sent to a wastewater facility or injected back into the subsurface. These methods are less than ideal because of the hazardous nature of fracking fluid.

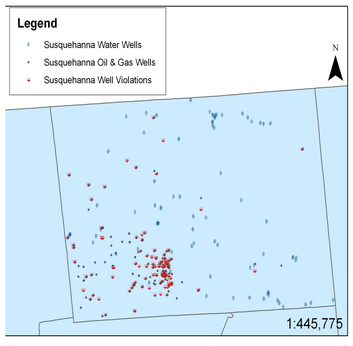
rilling companies are not legally obligated to disclose the contents of the fracking fluid they use. It is known that fracking fluid contains a number of toxic pollutants, including BTEX (aka diesel fuel, containing benzene, toluene, ethylbenzene, and xylene). (NYS DEC, 2009). Fracking fluid can easily leak from storage tanks, contaminating the subsurface. Subsurface pollution is also likely to come from the fracking fluid that is not recovered from the subsurface. (Berkowitz, 2010)

Fracking fluid pollution is a serious issue, particularly because the specific components of the fluid are generally unknown. Soil, surface water, and groundwater can be polluted from leaking surface storage and re-injection. Pollution is then likely to pass to organisms, including humans, creating a public health risk.

PURPOSE

The goal of this project was to identify the risk associated with hydraulic fracturing (fracking) in the Marcellus Shale formation. A Pennsylvania county with Marcellus bedrock, Susquehanna, was chosen to serve as a model area for risk assessment.





The above map shows the water and oil & gas wells in Susquehanna County, Pa. Well violations are also shown.

Susquehanna’s location in Pennsylvania is illustrated in purple on the map to the left. The blue coverage represents the extent of the Marcellus Shale Formation.

METHODS

Shapefiles of the Marcellus shale formation in the United States and Pennsylvania were obtained. Locations of water, oil, and gas wells and well violations in Pennsylvania were obtained from the PAGWIS and PASDA.
The three rasters described above were then summed to create a final overlay map for a comprehensive risk analysis.

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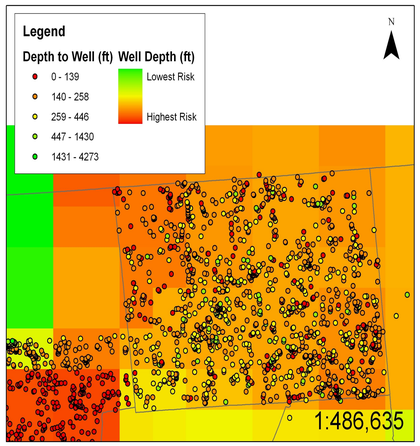
Well Depth

Water wells were classified by well depth and interpolated to produce a raster.

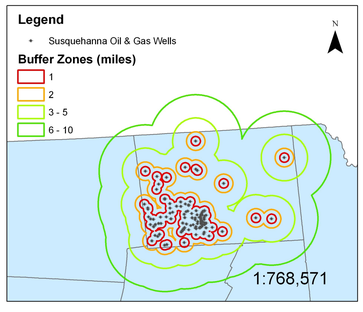
Well depth is considered indicative of the depth to the water table. Shallower wells are expected to be more prone to contamination as they are physically closer to surface spills, etc. Water wells in Susquehanna and surrounding Pennsylvania counties were considered. Nearby counties in neighboring New York as well as all of Pennsylvania counties were not considered, though they would provide a more full view of the groundwater table.

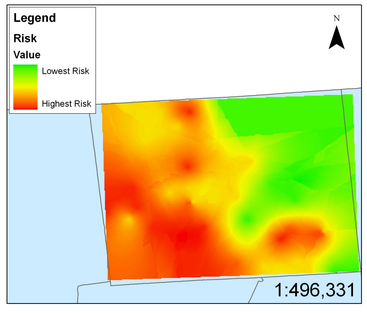


This map shows water wells classified by well depth,. The data was interpolated across a number of counties to produce the heat map shown.

Distance from Oil & Gas Wells

A multiple ring buffer was made around the oil & gas wells. Water wells were classified based upon the buffer and their distance to oil& gas wells. A raster was created by interpolating water well proximity to oil & gas wells.
Those water wells closest to oil & gas wells (i.e., in the smallest buffer ring) are considered having the greatest risk due to their proximity to pollutant sources. This increased risk is due to the possibility of surface spills and the possibility that groundwater contamination might reach withdrawal wells.
The Susquehanna River watershed was initially mapped but excluded because all wells were with in 1/10 of a



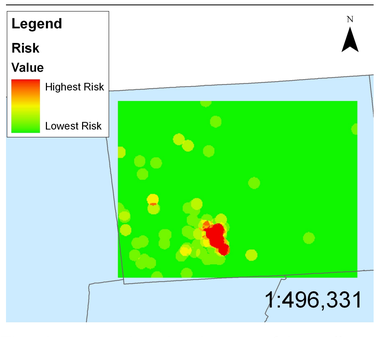


The map to the left shows the buffer zones of distance from oil & gas wells in Susquehanna. This data was then interpolated in the map to the right, showing the closest buffer area in red and the farthest in green.

Well Violations

Well violations were mapped and their geographical density was interpolated to produce a raster.

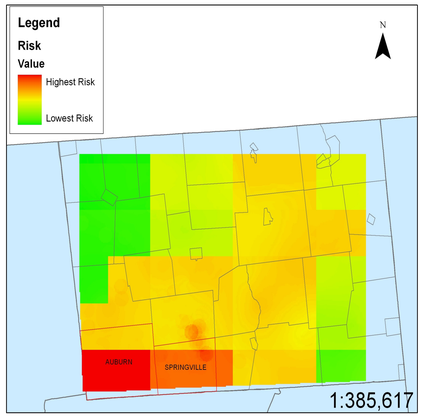
Areas with more well violations were understood to have a greater risk of pollution. This is because more violations could mean more spills, etc. Not all violations involved pollution but one could expect that a violating company is likely to accrue more violations.



The above map is a density map of the well violations in Susquehanna. The red represents the greatest density of violations

RESULTS & CONCLUSIONS

The final overlay raster considered the three factors in determining risk of water pollution due to fracking in Susquehanna County, Pennsylvania. The raster was produced using a weighted sum, (well depth = 0.25, distance = 0.40, and violations = 0.35).
The resulting raster shows the greatest risk of water contamination in the northwest corner of Susquehanna County. Municipality boundaries are shown. The two municipalities with greatest risk of water contamination are Auburn and Springville. While little can be done to reduce this risk directly, residents can still act to protect their water. Residents are advised to stay abreast of any drilling related news and to contact their local lawmakers regarding legal regulations and protections of their water sources.



LIMITATIONS

The data used for this analysis was severely limited and of lesser quality. Analysis had to be limited to a specific geographic region based upon what data was available. This was also necessary due to the time and skills constraints of this class project. The limited geographic reach does not allow for a complete analysis. Consequently, the results are biased towards the data that was used rather than presenting a “full picture” analysis.

More than half of the well data found did not include latitude and longitude coordinates and therefore could not be mapped. Many available data points lacked other crucial information (such as well depth) and had to be eliminated. Some information was incomplete, which prevented more detailed classification of data point (i.e., type of well violation).

Reliable water source data could not be found. Because the water table fluctuates constantly there was no consistent depth to water table data (which is why well depth was used instead). An extensive search of current instances of water pollution in Susquehanna yielded no results. General water quality data could be found but because fracking fluid components are unknown this data provided no insight into specific pollution sources.

Geological data was also lacking. An accurate map of Pennsylvania geology could not be found. Nor could data regarding surficial deposits and depth to bedrock. This lack of information limits an analysis of the influence of geology on pollution due to fracking.

General problems using ArcGIS, particularly when creating the final raster image, also limits the reliability of the final analysis.

Considering the various limitations in the data, any conclusions presented are expected to be significantly flawed. The analysis was based on a small portion of wells rather than the entire affected region, causing serious bias.

Data Sources

Pennsylvania Groundwater Information System (PAGWIS)
Pennsylvania Spatial Data Access (PASDA)
Pennsylvania Geological Survey
FracTracker Project 2011

References

Berkowitz, Michael. “Toxic Chemicals on Tap: How Natural Gas Drilling Threatens Drinking Water”. *Environment America Research and Policy Center.* November 2010.

Halliburton. “Halliburton Hydraulic Fracturing”. 2008.

NYS Department of Environmental Conservation (DEC), Division of Mineral Resources. September 2009.